Quality Comparison of W/O and O/W Photo-Protection Creams

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Key words

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Abstract

The authors determined the quality of a photo-protector W/O cream by evaluating its microbial control, physical-chemical stability and sensory appeal in comparison to an O/W photo-protector cream.

An emulsion used in photo-protection creams, like any emulsion, is a heterogeneous system made up of at least an immiscible liquid dispersed in another liquid in the form of small drops. These systems have only minimal stability, which can be increased by adding substances such as surfactants or finely divided solids.

It is possible to classify the emulsions into two distinct types – W/O and O/W – according to the nature of the respective dispersed phase because water and oil, as well as a lipo-soluble substance, are the two basic components of an emulsion.[1]

Sensorial tests enable us to measure how much volunteers like or dislike a certain product. They also enable us to identify the presence or absence of perceptible sensorial differences in characteristics such as the flavor, the texture, the color and the global impression, the spreading and the hydration sensation.[2]

In this article we describe how we determined the quality of a photo-protector W/O cream by evaluating its microbial control, physical-chemical stability and sensory appeal in comparison to an O/W photo-protector cream.

Photo-Protection

The melanin distribution inside the epidermis is one of the most important factors in protecting the skin against sun light-induced chronic damages such as skin aging and cancer. Nevertheless, melanin is a very poor classical solar filter, because it presents very little sun protection factor (SPF) in concentrations that can be considered biologically useful.

Melanin is a bio-chemically non-reactive free radical. It is unique in its capacity to neutralize the free radicals produced in the skin when skin is exposed to sunlight.[3] Because it is stable thermally and photo chemically, melanin is not degraded by enzymes. When topically applied, it neutralizes and removes the free radicals of the skin, besides working as an antioxidant. Its antioxidant properties are comparable to those of tocopherol because it is a water-soluble polyphenol and consequently stable under light and heat. However melanin cannot be used as a replacement to traditional antioxidants, but only together with them.[3]

The solar filter efficacy is determined "in vivo" through the SPF that is a numeric value. It is the ratio of the time required for a certain dose of UV exposure to provoke the appearance of perceptible erythema in protected skin of a given person to the time required for the same dose to provoke the same response in unprotected skin of the same person. An elevation of the SPF is observed in the following order, once the quantities of UV filters are kept constant in the different types of preparation: hydro-alcoholic lotion (one phase); ointments (one phase); o/w type emulsion (two phases); w/o type emulsion (two phases).[4]

One aim of this study was the quality determination of a photo-protector W/O cream, by determining the microbial contamination, the physical-chemical stability and a sensorial analysis of flavor, texture, color, spreading and global impression. Another aim was to determine how much consumers liked the product and whether they observed significant differences between the proposed W/O cream (Formula 1) and an O/W cream (Formula 2).

Methods

Microbial control: The total number of microorganisms and the presence of pathogenic ones – such as *Salmonella* sp, *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* – were analyzed according to methods described in the U.S.P.[5] and the British Pharmacopeia.[6]

Acceptance analysis: A team of 30 volunteers was used for the acceptance test. The team analyzed the two cream samples (Formulas 1 and 2) presented in six combinations of two occurrences of one sample and one occurrence of the other sample, coded each time with three-digit numbers. The volunteers used a nine-point structured hedonic scale[7] to report their degree of acceptance of the two samples based on five sensory attributes.

Data statistical analysis: Computer software[a] was used to obtain statistical analysis of the data by univariant variance analysis (ANOVA), Tukey average tests and histogram analysis of the volunteers' hedonic scale ratings for the five sensory attributes for each of the two samples.

Difference tests: The two cream samples (Formula 1 and Formula 2) were submitted to the difference triangular tests[9] performed by 30 volunteers. The x2 test[10] was used for the triangular test data analysis.

Spectrum-photometric analysis: The spectrum-photometric analysis was performed in a spectrophotometer[b] with quartz cubes of 1 cm optical path. Chloroform and isopropanol (V/V) were used as solving mixture. The base cream (Formula 1 without the analyzed filters) was used to zero the instrument. To verify the stability, the absorbance determination and absorption wavelength band of the filters (separately and mixed) were evaluated as well.

[a] *SAS User's Guide: Statistics, Cary, North Carolina: SAS Institute (1993)*
[b] *Hitachi U-2001 Spectrophotometer, Hitachi, Japan*

Formulas 1 and 2. Proposed W/O photo-protective cream (Formula 1) and an O/W photo-protective cream (Formula 2)

Raw material	Formula 1 W/O	Formula 2 O/W
Cetearyl glucoside/cetearyl OH	7.50%	3.00%
Ceteareth 20	-	3.00
Coco caprate /caprylate	10.00	3.00
Cetearyl alcohol	-	6.00
Dicaprylyl ether	4.00	3.00
Cetostearyl palmitate	-	3.00
Caprylic and capric acid triglyceride	1.00	3.00
Isopropyl myristate	-	4.00
Silicon fluid	0.50	1.00
Propylene glycol	3.00	3.00
Imidazolidinyl urea (Germall 115, Sutton)	qs	qs
Water dispersion at 2% of carboxyvinylpolymer	6.00	3.00
Lanolin ethoxy	-	2.00
pH Adjuster, adjust to pH = 6.0	qs	qs
Octyl salicylate	4.50	4.50
Camphor benzalkonium	7.50	7.50
Butyl methoxydibenzoylmethane	2.00	2.00
Water (*aqua*), distilled	qs 100.00	qs 100.00

Results and Discussion

Microbial control: The results showed that no *Salmonella* sp, *E. coli*, *S. aureus* and *P. aeruginosa* microbial growth occurred in the analyzed samples. The total microorganism count was less than 10 CFU/g of product, which is within permissible limits according Brazilian requirements.[11]

The microbiologic control has the aim of assuring that consumer products are of good quality, free of any pathogenic or potentially harmful microorganisms, permitting a

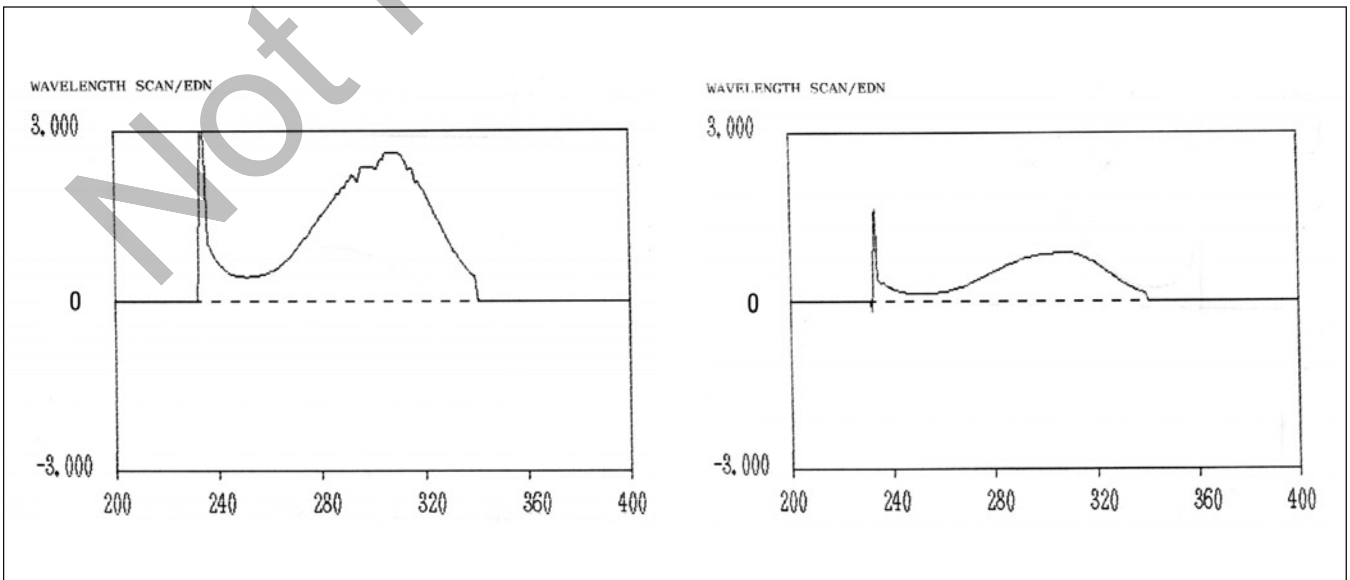

Figure 1. Spectrophotometric analysis of W/O cream (left) and O/W emulsion (right) following 28 days of thermal stress (45°C)

Table 1. Sample dispersal in the difference triangular tests and the number of people who were able to identify the sample that was different from the other two.
A = W/O emulsion B = O/W emulsion

Sample dispersal	Number of people who identified a different sample
A A B	19
A B A	26
B A A	25
B B A	24
B A B	23
A B B	25
Total	142

limited number of acceptable microorganisms. In this case, the testing for microorganisms used a series of cosmetic treatment agents that are good nutrient media.

The important point of exposing the microbial contamination of creams must be solved with allowance for their physicochemical properties and component composition that customarily hamper the isolation of microorganisms. This microbial contamination test is also used in pharmaceutical quality control, which meets the ANVISA (Agência Nacional de Vigilância Sanitária) requirements[12] of GMP (Good Manufacturing Practices).

Physical-chemical stability: Spectrophotometric analysis was carried out 24 hours after the cream was prepared and again after the cream was submitted to 28 days of thermal stress (45°C), yielding similar spectrophotometric profiles. This analysis suggests that these filters did not degrade after 28 days of thermal stress (Figure 1) and shows the stability of filters in the studied preparation under these conditions.

Sensorial analysis: Sensorial analysis consists of a complete and real characterization of the sensorial and tactile properties of cosmetic products. The volunteers must be able to detect and describe all the sensations related to product characteristics and properties. However, some precautions must be taken to avoid fatigue, mainly in smelling.

Table 1 shows the sample dispersal in the difference triangular tests and the number of people who were able to identify the sample that was different from the other two.

Table 2 shows the volunteers' average ratings of five attributes for the W/O emulsion and the O/W emulsion.

Through the significant minimum difference (SMD), which was obtained by the Tukey average test ($p \leq 0.05$), a comparison was performed among the averages, and again no significant difference between them was found.

When we compared the SPF for UVB using identical chemical filters in O/W and W/O emulsions, the W/O emulsions showed the higher SPF. We think this may be explained by the fact that the silicone fluid in the emulsion enables a higher water resistance value because of the formation of a hydrophobic film in the skin. The silicone fluid also improves the product's thixotropic properties.

However, this type of emulsion has been used rarely because of its low stability and sticky skin feel. For this reason some agents specific for W/O emulsions and with rheological properties were developed. Among them are the following:

- Cetearyl glucoside and cetearyl alcohol[c], which is an emulsifying agent that gives viscosity for cosmetic preparation without oily sensations;
- Dicaprylyl ether[d], an emollient product;
- Coco caprate/caprylate[e], an emollient and skin conditioning agent.

These agents are indicated for the preparation of photofilters in W/O emulsions because they increase the overall stability, product retention time on the skin and resist washoff. They also avoid a greasy sensation. So at least one

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[c] *Emulgade PL68/50, Henkel KgaA, Düsseldorf, Germany*
[d] *Cetiol OE, Henkel KgaA*
[e] *Cetiol LC, Henkel KgaA*

Table 2. Volunteer acceptance average of Samples 1, 2 for the studied attributes

Samples	Color	Flavor	Texture	Global Impression	Spreading
1 (A/O)	7.6000	5.5667	7.5000	7.1667	7.5667
2 (O/A)	7.7667	4.8000	7.3000	6.7000	6.9000

Averages in each column do not differ significantly between samples according to the Tukey average test ($p \leq 0.05$).

Table 3. Acceptance analysis (% acceptance) for W/O emulsion and O/W emulsion

Purchasing attitude	W/O	O/W
I would definitely not buy this product	0	0
I would probably not buy this product	10.0	16.66
I am not sure if I would buy it or not	30.0	30.0
I would probably buy this product	46.66	40.0
I would definitely buy this product	13.33	13.33
Total = 30		

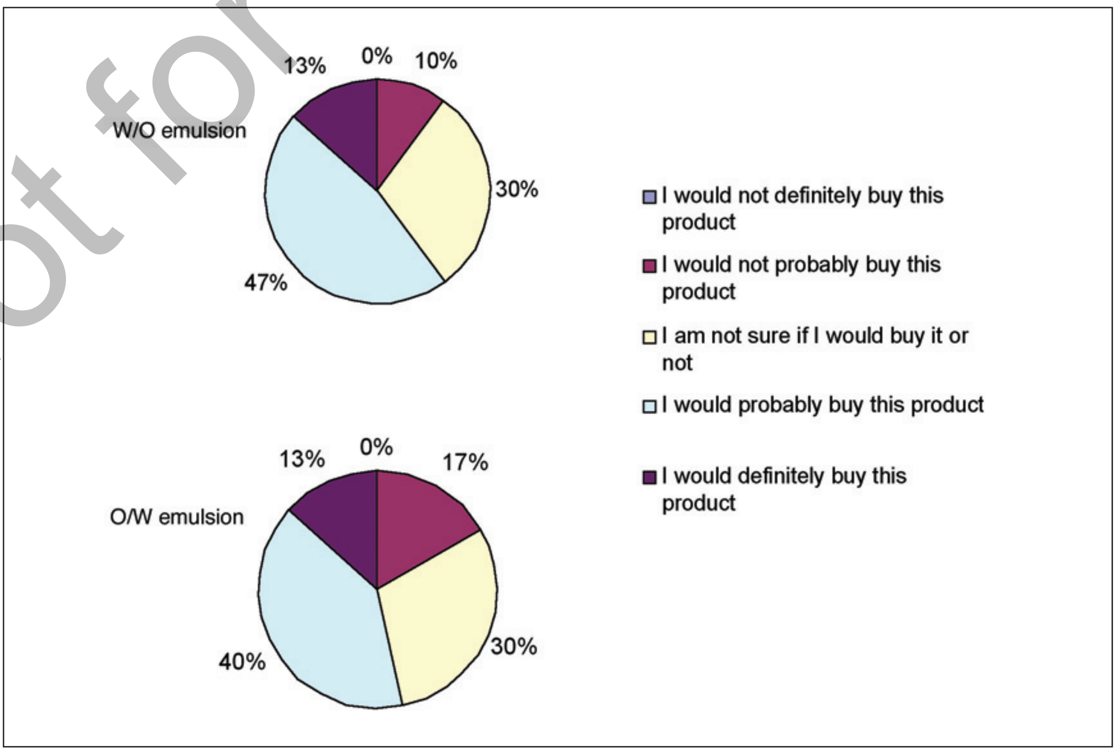

Figure 2. Acceptance analysis

source has concluded that the W/O emulsions are the best vehicles in preparing sun protection creams.[4]

The acceptance analysis (Table 3 and Figure 2) showed that 60% of the volunteers said they would definitely or probably buy the W/O product, compared to 53% for the O/W product. Usually, consumers prefer O/W emulsions because they give a dry sensation and a softer skin feel. The authors sought to develop a W/O emulsion that does not cause an oily skin-feel after use. The sensorial analysis showed the W/O emulsion is more acceptable than the O/W emulsion. So it is possible to develop a W/O emulsion that does not give the oily skin sensation that is characteristic of W/O emulsions.

Conclusion

This study determined the quality of a photo-protector W/O cream by evaluating its microbial control, physical-chemical stability and sensory appeal in comparison to an O/W photo-protector cream. Microbial challenge tests in cultures of the W/O cream showed that no microbial growth occurred. Spectrum-photometric analysis indicated the stability of the W/O cream by showing that there was no degradation in its solar filters. Sensorial analysis including a triangular test comparing the W/O cream and an O/W cream on five sensory characteristics indicated that there was no significant difference ($p<0.05$) between the two creams, and 60% of the volunteers said that they would probably or certainly buy the W/O product.

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